

# Contracting/Design Innovation Report

## I-40 Emergency Slide Repair



**Location:** I-40 Between Mile Markers 3 and 4

**Division:** 14

**County:** Haywood

**Type of Work:** Grading, Drainage, Structures, Paving, Retaining Wall and Toe Slope Protection

**Type of Contract:** A+B with Nested Design-Build

**Proposed Contract Completion Date:** June 1, 2005

**Contractor:** Phillips & Jordan, Inc.

**Geotechnical Subcontractor:** Schnabel Foundation Company

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Alternative Contracts, Constructability Engineer

## INNOVATION REPORT

**PROJECT #:** 112.104401

**COUNTY:** Haywood

**DIVISION:** 14

**FEDERAL AID #:** ER-NC05(2)

**DESCRIPTION:** This project consists of grading, drainage, paving, retaining walls and toe slope protection on I-40 in Haywood County to repair slide sites from Hurricane Ivan.

### **BACKGROUND**

The slopes of several portions of I-40 near the Tennessee border were left badly eroded from the floodwaters of Hurricane Ivan. This damage compromised the road and eliminated travel on the eastbound lanes. This left NCDOT searching for a means to get the repair under contract and the lanes open for travel quickly. In order to get the best retaining wall system possible, NCDOT wanted to select from the nation's premier geotechnical specialty contractors. In addition, the Division did not want a geotechnical contractor to serve as the "prime contractor". The Division wanted the geotechnical contractor to be a subcontractor to a prime that was familiar with the Department's processes and procedures and that could handle traffic control and grading. The Division felt the use of a prime contractor would expedite the project and would limit the amount of assistance needed from NCDOT staff. Prime contractors were also selected based on their availability to perform the work quickly.

The contractual method chosen to accomplish this task was a two step process. The first step used a design-build concept to select a retaining wall design/geotechnical subcontractor. The second step was to pair the selected subcontractor with a group of selected prime contractors and to use A+B bidding. The use of A+B bidding allowed time of lane closure, as well as cost, to factor into the selection of the contractor.

During the first step, NCDOT's Geotechnical Engineering Unit selected three geotechnical contractors based on their ability to do both rock and wall work. In addition, a fourth contractor was added after further discussions. The Division Construction Engineer selected four prime contractors. The selected contractors were invited to a meeting, at the project site, by the State Alternative Delivery Systems Engineer. This meeting was held on October 4, 2004. The design-build selection process was described at this meeting and the subcontractors were afforded 2 weeks to develop their technical and price proposals. The geotechnical subcontractors gave oral presentations of their technical proposal on October 19, 2004. Various wall designs discussed in the technical proposal included precast concrete tieback walls, a Reinforced Earth Company MSE wall, a soil nail wall and a reinforced shotcrete tieback wall. Scores were then given to

the proposals based on the evaluation criteria outlined in the contract. Price proposals were opened within 24 hours of the last presentation and adjusted based upon the technical scores. See the attached Appendix for a list of prices and scores. The selected contractor was then notified. Stipends in the amount of \$3,000 were paid to the geotechnical firms that gave oral presentations and turned in prices but were not selected for the job. Acceptance of the stipend allowed the NCDOT to use any ideas or information included in the technical proposals on this job or any future jobs.

The four selected prime contractors initially received Step 1 plans and proposals on October 15<sup>th</sup>. The Department's various design groups worked on a very aggressive time line to prepare these plans. A copy of the Emergency Slide Project Schedule has been included in the Appendix of this report. This initial package did not include the selected geotechnical subcontractor or the final wall design. After the subcontractor was determined, the primes received the Step 2, amended contract on October 21, 2004. This package included the name, technical proposal, price proposal and schedule of the successful wall subcontractor. The bid opening for the prime contractors was held on October 26<sup>th</sup>. Because the primes were required to submit payment and performance bonds with their bids, the contract office was able to execute the contract the same day that bids were opened. This differs from a standard bid opening where payment and performance bonds are obtained from the low bidder within 14 days after receiving the award letter from the contract office.

The prime contractor's contract included a \$7,000/day intermediate contract time (ICT) line item. This item covered the duration of time required to re-establish the I-40 eastbound traffic. The intermediate contract time, which was held to no more than 134 days, was used to adjust the bid prices, but did not figure into payment to the Contractor. Liquidated damages of \$7,000/day were applied to this ICT if the traffic was not shifted within the time frame stated by the contractor. Time durations submitted by the Primes for the ICT are in the Appendix as well as the adjusted numbers, which were used to award the contract.

The project completion date was set at June 1, 2005. Liquidated damages of \$1,000 per day were placed on completion of the project. These liquidated damages were not cumulative with any liquidated damages charged under the ICT.

A preconstruction conference was held on October 29<sup>th</sup>. The project was available to begin work November 1, 2004. The overall project design, including the toe scour protection and the retaining wall envelope, was prepared by Units within the Highway Design Branch. The responsibility of the geotechnical

subcontractor was to provide a retention system meeting the criteria established by the Geotechnical Engineering Unit.

Several innovative design aspects were incorporated into this project. For toe slope protection, the Hydraulics staff needed a flexible system that could withstand impacts from boulders during future flood events. After weeks of brainstorming between the Department's Hydraulic Unit, Geotechnical Engineering Unit and Structure Design Unit, it was decided to use ring nets to hold the toe scour protection in place. These energy absorbing ring nets are traditionally used as barriers for rockfall protection. For this project, the ring nets were used to actually wrap layers of rock. The ring nets allow the system to be somewhat flexible since they are anchored into the rocks using bolts and dowels. A gabion wall system was considered but dismissed due to its' inability to withstand future storm events and the extensive time required to build the gabions.

In addition, this project utilized an engineered retention system different from a traditional cast in place wall. Schnabel, the selected geotechnical contractor, proposed using shotcrete for the structural face of the wall. The price of the shotcrete wall system was about one half the price of the traditional cast in place system. To provide a more smooth appearance, NCDOT required a screed finish on the placed shotcrete. Since the project was let in the fall, there was some concern about placement of the shotcrete in the winter. Tents were used to warm the mix to temperatures appropriate for placement.

## **COMMENTS**

In speaking with staff from the Geotechnical Engineering Unit, Hydraulics Unit, Project Services Unit and Division staff, comments about the following topics were noted.

### **1. INNOVATIVE DESIGNS OR MATERIALS**

- There is some concern about the long-term durability of the shotcrete wall and its' ability to meet the maintenance free requirement in the specifications. Overall, though, the Resident Engineer is very impressed with the shotcrete wall system and feels it will perform very well over time.
- The Division is also very happy with the ring net system and is considering using the ring nets for future maintenance projects.
- The ring net system offers different sizes. The larger nets require equipment to be placed and should be used on the lower levels of scour protection. The smaller nets can be handled by several men and can be used for the top levels of toe scour protection. Both the NCDOT and the Contractor learned a lot about the application of this system during this job.

- In lieu of tensioned rock bolts, grouted rock dowels were used to hold the ring net system in place. The Contractor proposed using the grouted rock dowels for ease of construction and as a cost savings to NCDOT. The Geotechnical Engineering Unit approved the use of the dowels for this application, because the large mass of material on top of the ring net system holds it in place without anchors. Tensioned rock bolts, which are commonly specified, were structurally more than required for this use of the ring net system.



## 2. INNOVATIVE PROPOSAL/CONTRACT

- The NCDOT can not and does not target specific contractors. However, the emergency nature of this contract required contractors that were readily available to perform the work and that were familiar with NCDOT procedures. “Nested Design-Build” (design of one or more aspects included within a traditional low-bid job) and A+B Contracting can be used for letting emergency and non-emergency NCDOT projects.
- The innovative two-step nested design-build contract worked well to select a value-based wall design and construction within a low-bid construction project. The “forced” partnership between the prime contractor and the geotechnical subcontractor created by this project has made claim issues and liquidated damages (\$7,000/day for the ICT) more difficult on this project. This is largely due to the fact that

the retaining wall construction had to be completed before the traffic shift could occur. The relationship between the prime and subcontractor was contractually different from other projects. The geotechnical firm's contract with the prime excluded the subcontractor from responsibility for liquidated damages. The prime contractor was forced to accept these terms because NCDOT selected the subcontractor. While the prime contractor was responsible for the liquidated damages, it was really the subcontractor's schedule that controlled the progress of the project. The Division still feels the use of a general contractor as a prime is necessary and should be used on future projects but that the relationship between the subcontractor and the prime should not be forced.

- In reviewing the price proposals for the various wall systems, it is important to note that one proposal covered the cost of the wall system but did not include the prices of installation. The proposal stated the prime contractor would be capable and responsible for the construction of the wall. There is no way to fairly compare this price with the other three proposals, since those prices include the complete wall system. Another proposal included the price for stone needed for fill behind the wall, but stated the prime contractor should be able to provide this item at a lesser expense to the Department.
- The maximum Quality Credit Percentage for this project was 60% for the Step 1 geotechnical subcontractor selection. This percentage is much higher than what has been used on other design-build jobs. This reflects the desire to place more emphasis on a quality design than the bottom line price. The bid results reflect this with the top scoring and most expensive design being within \$11,100 of the adjusted low bidder, who earned a much lower technical score.

### **3. RIGHT OF WAY/UTILITIES**

- There was no work involving utilities or right of way included in the scope of this project.

### **4. CONSTRUCTION**

- The I-40 roadway embankment filled with cobbles and boulders on this job made drilling very difficult. The subcontractor had proposed using a tracked drill rig due to the limited space in which they could work. The equipment the subcontractor brought in initially was inadequate and as a result progress was very slow. The Subcontractor brought in an experienced drill operator to make new equipment adjustments. Also, the subcontractor mobilized a third drill rig. Progress increased after the arrival of new equipment.
- A large number of voids were encountered while trying to pump grout into drilled holes to secure the tiebacks. Due to these large voids,

large quantities of grout and time were being lost. A supplemental agreement was added to the project to add steel casing. The casing was used to sleeve the tieback holes to the point of solid rock. Savings realized by reducing time and grout quantity overruns offset the cost of the casings.

- Temporary wood lagging was required in the original contract for the top tier of wall 2 and was considered incidental to the construction. After construction began on the second tier of the wall, it was determined temporary wood lagging was required for construction of the bottom two tiers of the wall. A supplemental was written to cover the cost of the temporary wood lagging with the contractor agreeing to install the material at their cost to expedite construction.

## 5. ADMINISTRATION

- The contractor provided contract surveying by supplemental agreement. Inspection was provided by NCDOT.
- A supplemental agreement was added to the project to repair another slide adjacent to this project. The adjacent slide (site 3) was only accessible from this project without extensive unnecessary grading. There was also no suitable staging area at site 3. The work at site 3 consisted of extending the toe scour protection approximately 625 feet. The slope was then regraded and rock-plated. No retaining wall was constructed at the third slide site. NCDOT saved money and time by including this work as a supplemental agreement.



## **6. EROSION CONTROL/PERMITTING**

- Erosion control plans were prepared by the Department and attached to the Step 2 Proposal Package by Addendum Number 1 dated October 21, 2004. The field personnel did not mention any unusual erosion control issues.
- After the storm, photogrammetry flew the stretch of I-40 from Clyde to the Tennessee border. To establish jurisdictional limits on this project, hydraulics used a combination of field data, aerial photos from 1992 and the aerial photos taken after the storm event. In the field, the State Hydraulics Engineer noted large boulders that probably would not have been displaced by the storm and that were of recognizable shapes. In the office, he compared the location of the recognizable boulders on the aerial photos showing pre and post storm conditions. The recognizable boulders had not shifted from the storm and became landmarks that were then used to help establish the position of the ordinary high water line. The Army Corp of Engineers allowed this established line to serve as the jurisdictional limits of the project. Locations and Surveys then spray painted the limits on the ground using the boulders as their landmarks.
- When the supplemental agreement was added to repair site 3, Hydraulics was able to use the aerial photography to establish jurisdictional limits. This site had not been field verified but the Corp was so confident in the method used to establish these lines that additional field verification was not required.

## **7. SAFETY**

- Slip form concrete barrier was added by supplemental agreement to this project in lieu of the specified precast concrete barrier. The Division prefers not to use precast barrier on any roads with excessive horizontal or vertical curvature. Precast barrier in areas of curvature is difficult to pin together, has visible joints and does not appear to be as safe. The upgrade to slip form barrier from precast cost an additional \$55/lf for this project.

## **8. WARRANTY**

- No warranty beyond the 12-month guarantee period was required on this project. The long-term maintenance requirements of the wall design were included in the scoring component of the subcontractor. During their technical proposal, the subcontractors were instructed to identify and discuss all aspects of the durability of the proposed wall system and components. A maximum of 20 (out of 100) points could be awarded for this aspect of the design. The subcontractor was instructed to design all components for a 100 year design life.

## 9. FOLLOW UP

- A contract was let in June 2005 for repair of an additional slide area. Because of the relationships established and the contractual issues that arose in the previous slide repair job, this contract did not utilize a nested Design-Build concept. This contract allowed submission of a wall design paid for by a generic wall pay item. The geotechnical subcontractor on this project is Hayward Baker. Their design utilizes a precast wall. The wall uses 24" steel pipe piles (in lieu of H piles with casings) filled with concrete, with welded lagging, timbers and precast panels.



## **RECOMMENDATIONS**

The following comments and recommendations are made to assist the NCDOT.

- It is our recommendation that the Geotechnical Engineering, Hydraulics, and Structure Designs Unit submit the design of the ring net system for a CPI award.
- It is our recommendation that further investigation be made into the use of precast versus slipform concrete barrier on roads with horizontal and vertical curvature. Based on the results of the investigation, guidelines may need to be developed to properly cover this issue.
- While forcing a "team relationship" in an emergency situation worked for this project, it may be better to allow primes and subs to establish their own partnerships.
- General items to be included within price proposals for nested Design-Build projects should be clearly stated (all materials, construction, etc.). If prices for all items are not included in the proposal the bidder should be considered non-responsive. The Department should consider allowing the proposal to break out one or two items that the prime may be able to provide for a lower cost. These items could be deducted out of the subcontractor's price proposal and included in the prime's scope of work if desired.

**APPENDIX**

**Step 1:** This contract used both a Technical and a Price Proposal for the selection of the geotechnical subcontractor. The bid information is as follows:

Engineer's Estimate: \$2,275,000.00

<u>VENDOR</u>	<u>TECHNICAL SCORE</u>	<u>QUALITY CREDIT (%)</u>	<u>PRICE PROPOSAL</u>	<u>QUALITY VALUE</u>	<u>ADJUSTED PRICE</u>
BRAYMAN CONSTRUCTION	97	54.00	\$4,062,450.00	\$2,193,723.00	\$1,868,727.00
HAYWARD BAKER	70	0.00	\$2,174,468.50	\$0.00	\$2,174,468.50
RICHARD GOETTLE, INC.	86	32.00	\$4,695,000.00	\$1,502,400.00	\$3,192,600.00
SCHNABEL FOUNDATION CO	77	14.00	\$2,160,000.00	\$302,400.00	\$1,857,600.00

Based on the adjusted price, Schnabel Foundation Co. was selected to perform the work.

**Step 2:** This contract used A+B Bidding to award the Step 2 (Prime Contractor) portion of this project. A \$7,000/day contract time item was included. The bid information is as follows:

NCDOT's Availability Date: November 01, 2004

NCDOT's Completion Date: June 1, 2005

<u>CONTRACTOR</u>	<u>ACTUAL CONTRACT AMOUNT</u>	<u>INTERMEDIATE CONTRACT TIME</u>	<u>CONTRACT AWARD BASIS *</u>	<u>% DIFF</u>
ESTIMATED	\$6,284,215.25	134 DAYS	\$7,222,215.25	
PHILLIPS & JORDAN	\$7,714,740.53	100 DAYS	\$8,414,740.53	+16.5%
TAYLOR & MURPHY	\$7,746,137.34	120 DAYS	\$8,586,137.34	+18.9%
CHARLES BLALOCK & SONS	\$8,975,962.75	134 DAYS	\$9,913,962.75	+37.3%

\*Contract Award Basis = Actual Contract Amount + Intermediate Contract Time x \$7,000/day

Based on the contract award amount, Phillips & Jordan, Inc. was selected to perform the work.

## Interstate 40 Milepost 3 & 4 Emergency Slide Project Schedule

<u>Date</u>	<u>Activity</u>
September 17, 2004	Hurricane Ivan strikes western North Carolina causing major damage to I-40 near the Tennessee Border
September 22, 2004	Location and Surveys Place Panels
September 22, 2004	Photogrammetry Flies Project
September 23, 2004	Highway Design Branch Meets to Determine Scope of Work
September 24, 2004	Location and Surveys to Provide Base Line Surveys and Panel Controls to Photogrammetry
September 24, 2004	Geotechnical Engineering to Start Borings on I-40 Roadway Level
September 24, 2004	Division to Obtain Permit for Lower Borings in River
September 28, 2004	Photogrammetry to Provide Shell Mapping and Preliminary DTM to Roadway Design
September 29, 2004	Location and Surveys to Provide Obscured Areas for DTMs to Photogrammetry
October 1, 2004 (A.M.)	Roadway Design to Provide Preliminary Plans and Cross Sections to Geotechnical Engineering, Hydraulics, Structure Design and Division
October 1, 2004 (P.M.)	Photogrammetry to Provide Final Surveys and DTMs to Roadway Design
October 4, 2004	Meeting with Selected Prime Contractors and Wall System Subcontractors at the Project Site
October 4, 2004	Roadway Design to Provide Final Plans and Cross Sections to Geotechnical Engineering, Hydraulics, Structure Design and Division
October 4-8, 2004	Roadway Design, Geotechnical Engineering, Structure Design, Hydraulics, and Division Coordinate on Final Design
October 13, 2004	All Plans are Turned in to Roadway Design
October 14, 2005	Roadway Design to Submit Plans for Letting
October 15, 2004	Selected Prime Contractors and Wall System Subcontractors Receive Step 1 Plans and Proposal
October 19, 2004	Wall System Subcontractor Oral Presentations
October 20, 2004	Open Subcontractor Price Proposals, Select Wall Subcontractor
October 21, 2004	Selected Prime Contractors Receive Step 2 Plans and Proposals
October 26, 2004	Open Prime Price Proposals, Award and Execute Contract
October 29, 2004	Preconstruction Meeting
November 1, 2004	Date of Availability